DEPARTMENT OF TRANSPORTATION WEATHER PROGRAMS

The Federal Aviation Administration (FAA) has the responsibility to provide national and international leadership in the optimization of aviation weather systems and services. This leadership is manifested through the management of a safe and efficient National Airspace System (NAS) and the encouragement of consensus and cooperation between government agencies, private weather services, research organizations, and user groups involved in aviation weather. The Federal Highway Administration (FHWA) manages programs that provide federal financial and technical assistance to the states, promotes safe commercial motor vehicle operations, and provides access to and within national forests and parks, native American reservations, and other public lands. Safety, efficiency, and mobility in these programs requires the incorporation and use of timely weather and road condition information. The United States Coast Guard (USCG) meteorological activities include the taking, collection, and transmission of marine and coastal weather warnings and observations; deployment and maintenance of offshore environmental monitoring buoys; and the operation of long-range radionavigation networks.

FEDERAL AVIATION ADMINISTRATION

AVIATION WEATHER MANAGEMENT

NAS Management. For the last few years, the Federal Aviation Administration (FAA) has been focusing on initiatives to prevent accidents and delays attributable to weather. The focus on these initiatives underscored the need for centralized aviation weather program management. Feedback from users and other weather service providers only reinforced the FAA commitment to meet that need.

On October 1, 1995, the Aviation Weather Division was established and staffed with personnel from diverse backgrounds, such as flight standards, meteorology, airway facilities, and air traffic. A reorganization that established the Air Traffic Requirements Service in early 1997 elevated Aviation Weather to a Directorate.

The Aviation Weather Directorate is working diligently to reaffirm FAA's leadership role in meeting aviation weather requirements and service.

FAA has been focusing on four major areas for aviation weather services:

- Roles and responsibilities.
- Training.
- Technology.
- Investment strategies.

This focus has provided some immediate benefits and, more importantly, will strengthen the foundation for future NAS services.

Roles and Responsibilities. The successful execution of a national aviation weather program is first dependent upon an explicit and mutually understood definition and acceptance of roles and responsibilities both within and outside of the FAA. The execution of these roles and responsibilities have been enhanced by the chartering and complete staffing of the Aviation Weather Directorate, clarifying FAA lines of business, and completing intra-agency and interagency plans.

Training. Aviation weather information, which is complex and highly perishable, is most useful when customers can successfully plan, act, and respond in ways that avoid accidents and delays. FAA will improve the ability of the aviation community to use weather information through a review and upgrade of airmen training and certification programs. FAA will also develop multimedia training tools to support aviation safety and training initiatives.

Technology. Aviation weather technology includes the ways in which aviation weather information is gathered, disseminated, and displayed. The development of this technology also demands that consideration be given to human factors and the application of decision-making tools. FAA will support the use of technology improve aviation weather information through integration of federal and non-federal resources.

Investment Strategies. Sound investment strategies are characterized by the integration of many activities, primarily those of identifying, planning, and evaluating. FAA has developed a sound investment strategy for a national aviation weather program that:

- Communicates the aviation weather objectives.
- Describes where the FAA wants to be.
- Considers all FAA and non-FAA funding for aviation weather that contributes to NAS performance.
- Develops and uses metrics that provide information on the performance of the national aviation weather program.

AVIATION WEATHER ACQUISITION AND SERVICES

One of the primary functions of the new organization is the development and management of requirements for the FAA Capital Investment Plan. Recent projects have focused on weather detection and display systems for pilots and air traffic controllers to ensure that aircraft avoid hazardous weather. The following paragraphs describe those projects.

Terminal Aviation Weather Programs

The Integrated Terminal Weather System (ITWS) will integrate weather data from sensors in the terminal area to provide and display compatible, consistent, real-time products that require no additional interpretation by controllers or pilots--the primary users. ITWS will use data from automated surface observing systems, Doppler weather radars, and low-level windshear alert systems, together with NWS data and products, to forecast aviation impact parameters, such as convection, visibility, icing, and windshear, including downbursts. Initial capabilities will include sensors available now through the early years of the 21st Century. The development is now in the demonstration phase at several airports in various climatic regimes. There will be 34 ITWSs which will provide displays at 46 high activity airports that are supported by terminal Doppler weather radars. Full production is expected by the end of calendar year (CY) 2001 (Figure 3-DOT-1).

The Terminal Doppler Weather Radar (TDWR) program consists of the procurement and installation of a new terminal weather radar based on Doppler techniques. TDWR units will be located to optimize the detection of microbursts and windshear at selected high activity airports. In addition, it will have the capability to identify areas of precipitation and the locations of thunderstorms (Figure 3-DOT-2).

Microbursts are weather phenomenon that consist of an intense downdraft with strong surface outflows. They are particularly dangerous to aircraft that are landing or departing. TDWR scanning strategy will be optimized for microburst/windshear detection. The radar will be located near the airport operating areas in a way to best scan the runways, and the approach and departure corridors. The displays will be located in the tower cab and Terminal Radar Approach Control (TRACON).

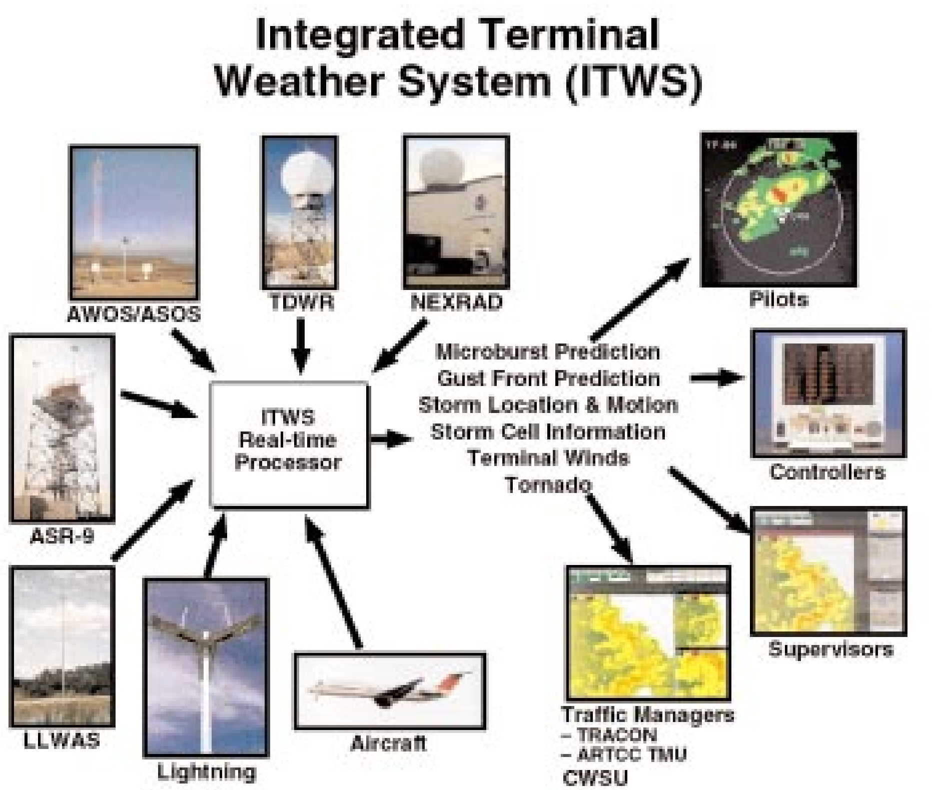

Figure 3-DOT-1. The ITWS will integrate data from FAA and NWS sensors and systems to provide a suite of weather informational products.

FAA has 39 TDWR systems commissioned and the remaining 6 systems will be commissioned by the end of CY 2002. A software upgrade has been initiated to integrate TDWR and low level windshear alert system data.

The Low Level Windshear Alert System (LLWAS) provides pilots with information on hazardous windshear conditions that create unsafe conditions for aircraft landings and departures. A total of 110 airports have LLWAS. The 101 basic systems, LLWAS-2, consists of a wind sensor located at center field and 5 or more sensors near the periphery of the airport (Figure 3-DOT-3). A computer processes the sensor information and displays windshear conditions on an ITWS display to air traffic controllers for relay to pilots. The improvement phase, referred to as LLWAS-Relocation/Sustainment (LLWAS-RS), will include expanding the network of sensors, developing improved algorithms for the expanded network, and installing new information/alert displays. The new information/alert displays will enable controllers to provide pilots with head wind gain or loss estimates for specific runways. These improvements will increase the system's windshear detection capability and reduce false alarms. Improvements are also expected to reduce maintenance costs. Forty LLWAS–RS are scheduled to be deployed by CY 2001 to work in conjunction with TDWR. These systems will provide a synchronous alarm of windshear to the air traffic controller; in fact, development of a system is underway that will integrate the information from these two systems into a single windshear display. Investigation is also underway on how integrated windshear information can best be communicated or displayed to the pilot.

The Surface Weather Observing Program. The FAA has taken responsibility for observations at many airports all across the country. To provide the appropriate observational service, FAA will use automated systems, human observers, or a mix of the two. It has been necessary to place airports into four categories according to the number of operations per year, any special designation for the airport, and the frequency at which the airport is impacted by weather.

- Level D service is provided by a stand-alone Automated Weather Observing System (AWOS) or an Automated Surface Observing System (ASOS). In the future, Level D service may be at as many as 400 airports.
- Level C service includes the ASOS/AWOS plus augmentation by tower personnel. Tower personnel will add to the report observations of thunderstorms, tornadoes, hail, tower visibility, volcanic ash, and virga when the tower is in operation. Level C service includes about 250 airports.
- Level B service includes all of the weather parameters in Level C service plus Runway Visual Range (RVR) and the following when observed--freezing drizzle versus freezing rain, ice pellets, snow depth and snow increasing rapidly remarks, thunderstorm/lightning location remarks, and remarks for observed significant weather not at the station. Level B service includes about 57 airports.
- Level A service includes all of the weather parameters in Level B service plus 10-minute averaged RVR for long-line transmission or additional visibility increments of 1/8, 1/16, and 0 miles. Level A service includes about 78 airports.

Automated surface weather observing systems will provide aviation-critical weather data (e.g., wind velocity, temperature, dew point, altimeter setting, cloud height, visibility, and precipitation type, occurrence, and accumulation) through the use of automated sensors. These systems will process data and allow dissemination of output information to a variety of users, including pilots via computer-generated voice.

FAA has deployed Automated Weather Observing Systems (AWOS) at over 200 airports to provide the basic aviation weather observation information directly to pilots approaching the airport. The majority of these systems were installed at various non-towered airports to enhance aviation safety and the efficiency of flight operations by providing real-time weather data at airports that previously did not have local weather reporting capability. These systems are built to the standards of quality necessary to ensure the safety of flight operations and are available off-the-shelf as a commercial product.

The FAA has negotiated with the National Oceanic and Atmospheric Administration (NOAA) to procure, install, operate, and maintain Automated Surface Observing Systems (ASOS) at the remaining airports where the FAA provides observations and at additional non-towered airports without weather reporting capabilities. A production contract was awarded in February 1991. The FAA has 568 systems installed and will have all commissioned by mid CY 2000.

Figure 3-DOT-2. FAA Terminal Doppler Weather Radars provide supplementary wind and precipitation conditions for airport approach and departure.

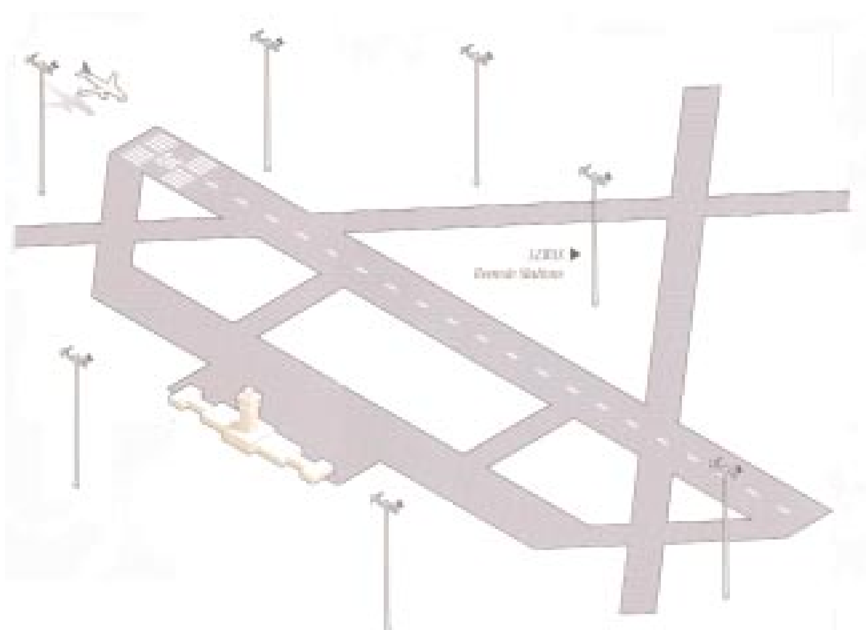

Figure 3-DOT-3. Artists drawing of LLWAS tower positions on an airfield.

The AWOS/ASOS Data Acquisition System (ADAS) will function primarily as a message concentrator and will collect weather messages from AWOS and ASOS equipment located at controlled and non-controlled airports within each air route traffic control center's (ARTCC) area of responsibility. ADAS will distribute minute-by-minute AWOS/ASOS data to the Weather and Radar Processor (WARP) within the air route traffic control center in which it is installed. ADAS will also distribute AWOS data to the National Airspace Data Interchange Network (NADIN) which will in turn forward the data to Weather Message Switching Center Replacement (WMSCR) for further distribution. Field implementation of ADAS has been completed.

Automated Lightning Detection and Reporting System (ALDARS). ALDARS is a system adjunct to the ADAS. It collects lightning stroke information from the National Lightning Detection Network and disseminates this data to AWOS/ASOS for the reporting of thunderstorms in METAR or SPECI observations, when appropriate. The use of ALDARS eliminates the need for manual reporting of thunderstorms.

Stand Alone Weather Sensors. These sensors are planned to be back-up for some AWOS/ASOS sensors at locations where no other back-up capability is available. Full delivery is expected by CY 2001.

AWOS for Non-Federal Applications. Under the Airport Improvement Program (AIP), state and other local jurisdictions may justify to the FAA their need to enhance their airport facilities. Upon approval, these improvements may be partially funded by the FAA using resources from the Airway Trust Fund. The local airport authority becomes responsible for the remainder of the funding necessary to complete the procurement as well as the funding for the regular maintenance. The addition of an AWOS is one of the improvements that qualify for AIP funding assistance. Systems that qualify must meet certain standards which are defined in an FAA Advisory Circular on Non-Federal Automated Weather Observing Systems.

There are currently five versions of the non-Federal AWOS. An AWOS-A provides only altimeter setting. The AWOS I system contains sensors to measure wind direction and speed, ambient and dew point temperatures, altimeter setting, and density altitude. The AWOS II contains the AWOS I sensors plus a visibility sensor; AWOS III adds a cloud height sensor to an AWOS II. AWOS IV will include AWOS III capabilities plus the option for precipitation identification, thunderstorm detection, and runway surface condition. Most importantly, all versions are required to have the capability to broadcast a minute-by-minute update of the current weather to the pilot by radio, using a computer-generated voice output. AWOS III also enables the pilot, as part of their preflight activities, to call the AWOS and obtain the current weather observation. In addition, the observation may be transmitted to the database within the national weather network.

There are more than 275 non-Federal AWOS locations. Some of these are capable of reporting through a geostationary communications satellite, and many more will acquire that capability during the year. These observations will be entered into the national network for use in support of the NAS and the national weather network.

The New Generation Runway Visual Range (RVR) program provides for a new generation RVR sub-element of the NAS. The RVR provides runway visual range information to controllers and users in support of precision landing and takeoff operations. The new generation RVR incorporates state-of-the-art sensor technology and imbedded remote maintenance monitoring. FAA plans to procure and install these RVR systems at all new qualifying locations. FAA plans also call for the replacement of many existing RVRs in the NAS inventory.

The RVR provides for near real-time measurement of visibility conditions along a runway (up to three points along the runway can be measured--touchdown, midpoint, and rollout) and reports these visibility conditions to air traffic controllers and other users. The system automatically collects and formats data from three sensors: a visibility sensor--forward scatter meters will replace the transmissometers currently in use, a runway light intensity monitor for both runway edges and center-line lights, and an ambient light sensor which controls computer calculations using a day or night algorithm. The data processing unit calculates RVR products and distributes the products to controllers and other users.

A total of 528 RVR visibility sensors will be deployed at 264 airports. Delivery of the new RVR sensors began in November 1998. Sixty new RVRs have been fielded with the rest expected by the end of CY 2001. Enhancements are planned to interface with the Tower Control Computer Complex and the ASOS by mid 2000.

En Route Aviation Weather Programs

The FAA is procuring the Operational and Supportability Implementation System (OASIS) to improve weather products, flight information, aeronautical data collection, analysis, and timeliness of dissemination and, thereby, enhance the safety and efficiency of the NAS. OASIS will replace the Model-1 Full Capacity Flight Service Automation System, which includes the Aviation Weather Processor. OASIS will also integrate the Interim Graphic Weather Display System functions and include several automated flight service data handling capabilities. This configuration will be its initial deployment capability. Operational testing began in 1999; full deployment will commence in FY 2001.

Future enhancements leading to the full capability deployment will include: interactive alphanumeric and graphic weather briefings, direct user access terminal (DUAT) service functionality, automated special use airspace, and training support. OASIS will support flight planning, weather briefings, NOTAM service, search and rescue, and pilot access terminal services.

The Next Generation Weather Radar (NEXRAD), known operationally as the Weather Surveillance Radar-1988 Doppler (WSR-88D), is a multiagency program that defined, developed, and implemented the new weather radar.

Field implementation began in 1990 and was completed in 1996. There are a total of 161 WSR-88D systems deployed. The FAA sponsored 12 systems in Alaska, Hawaii, and the Caribbean. DOC and DOD WSR–88Ds provide coverage over the continental United States.

The FAA emphasized the development of WSR-88D algorithms that take advantage of the improved detection of precipitation, wind velocity, and hazardous storms. The FAA also stressed that these algorithms provide new or improved aviation-oriented products. These improvements in detection of hazardous weather will reduce flight delays and improve flight planning services through aviation weather products related to wind, windshear, thunderstorm detection, storm movement prediction, precipitation, hail, frontal activity, and mesocyclones and tornadoes. WSR-88D data provided to ATC through the WARP will increase aviation safety and fuel efficiency.

In addition, the three funding agencies support the field sites through the WSR-88D Operational Support Facility (OSF) at Norman, Oklahoma. The OSF provides software maintenance, operational troubleshooting, configuration control, and training. Planned product improvements include a shift to an open architecture and the development of more algorithms associated with specific weather events, such as hurricanes.

A new Air Route Surveillance Radar (ARSR-4) provides the ARTCCs with accurate multiple weather levels out to 200 nautical miles. The ARSR-4 is the first en route radar with the ability to accurately report targets in weather. The ARSR-4 can provide weather information to supplement other sources. The ARSR-4 is a joint FAA/USAF funded project. Forty joint radar sites were installed during the 1992-1995 period.

Aviation Weather Processing Programs

The Weather and Radar Processor (WARP), Stage 0 has replaced the Meteorologists Weather Processor to provide aviation weather information to the Center Weather Service Units. Stage 1 and 2 will automatically create unique regional, WSR-88D-based, mosaic products, and send these products, along with other time-critical weather information, to controllers through the Display System Replacement and to pilots via the Flight Information system (FIS). WARP will greatly enhance the dissemination of aviation weather information throughout the NAS. WARP is currently undergoing operational testing and evaluation and will be fielded at the ARTCCs in CY 2000.

The Direct User Access Terminal (DUAT) system has been operational since February 1990. Through DUAT, pilots are able to access weather and NOTAMs and also file their IFR and/or VFR flight plans from their home or office personal computer. This system will eventually be absorbed into OASIS.

Aviation Weather Communications

It should be noted that FAA communications systems are multipurpose. Weather data, products, and information constitute a large percentage of the traffic, as do NOTAMS, flight plans and other aeronautical data.

The National Airspace Data Interchange Network (NADIN II) packet-switched network was implemented to serve as the primary interfacility data communications resource for a large community of NAS computer subsystems. The network design incorporates state-of-the-art packet-switching technology into a highly connected backbone network, which provides extremely high data flow capacity and efficiency to the network users. NADIN II consists of operational switching nodes at each Area Control Facility and two network control centers (and nodes) at the National Aviation Weather Processing Facilities at Salt Lake City, Utah, and Atlanta, Georgia. It will interface directly to WMSCR, WARP, ADAS, TMS, ACCC, and the Consolidated NOTAM System. NADIN II also may be used as the intra-facility communications system between these (collocated) users during transition to end state.

The Weather Message Switching Center Replacement (WMSCR) replaces the weather message switching center (WMSC) located at FAA's National Communications Center (NATCOM), Kansas City, Missouri, with state-of-the-art technology. It performs all current alphanumeric weather data handling functions of the WMSC and the storage and distribution of NOTAMs. WMSCR will rely on NADIN for a majority of its communications support. The system will accommodate graphic data and function as the primary FAA gateway to the NWS' National Centers for Environmental Prediction (NCEP)--the principal source of NWS products for the NAS.

To provide for geographic redundancy, the system has nodes in the NADIN buildings in Atlanta, Georgia, and Salt Lake City, Utah. Each node supports approximately one-half of the United States and will continuously exchange information with the other to ensure that both nodes have identical national databases. In the event of a nodal failure, the surviving one will assume responsibility for dissemination to the entire network.

The Flight Information Service is a new communications systems to provide weather information to pilots in the cockpit. FIS is a partnership program among the government and private industry with the government providing the base information and the bandwidth and the private companies the broadcast and value-added products. New products are screened for technical suitability and value to the pilots.

The Worldwide Aeronautical Forecast System (WAFS) is a three geosynchronous satellite-based system for collecting and disseminating aviation weather information and products to/from domestic or international aviation offices as well as in-flight aircraft. The information and products are prepared at designated offices in Washington, District of Columbia, and Bracknell, United Kingdom. The United States portion of WAFS is a joint project of the FAA and NWS to meet requirements of the member states of the International Civil Aviation Organization (ICAO). FAA funds the satellite communications link, and the NWS provides the information stream.

Two of the three satellites are funded by the United States. The first is located over the western Atlantic with a footprint covering western Africa and Europe, the Atlantic Ocean, South America, and North America (except for the West Coast and Alaska). The second United States-funded satellite is positioned over the Pacific and covers the United States West Coast and Alaska, the Pacific Ocean, and the Pacific rim of Asia. The third satellite is stationed over the western Indian Ocean and covers the remaining areas of Europe, Asia, and Africa.

The data available via WAFS include flight winds, observations, forecasts, SIGMETs, AIRMETs, and hazards to aviation including volcanic ash clouds.

AVIATION WEATHER RESEARCH PROGRAM

Working closely with the Integrated Product Team for Surveillance and Weather, the Aviation Weather Directorate sponsors research on specific aviation weather concerns, such as in-flight icing. This research is performed through collaborative efforts with the National Science Foundation (NSF), the NWS, and the Massachusetts Institute of Technology's Lincoln Laboratory. A primary concern is the effective management of limited research, engineering, and development resources.

Improved Aircraft Icing Forecasts. The purpose of this initiative is to establish a comprehensive multi-year research and development effort to improve aircraft icing forecasts as described in the FAA's Aircraft Icing Plan. The objectives of this plan are to develop: (1) an icing severity index, (2) icing guidance models, and (3) a better comprehension of synoptic and mesoscale conditions leading to icing. The result of this effort will be an improved icing forecasting capability that provides pilots with more timely and accurate forecasts of actual and expected icing areas by location, altitude, duration, and potential severity.

Convective Weather Forecasting. The purpose of this research effort is to establish more comprehensive knowledge on the conditions that trigger convection and thunderstorms and, in general, the dynamics of a thunderstorm's life cycle. The program will lead to enhanced capability to predict growth, movement, and type of precipitation from thunderstorms. Gaining this forecast capability will allow better use of the airspace and help aircraft avoid areas with hazardous convective conditions.

Model Development and Enhancement. This research is aimed at developing or improving models to better characterize the in-flight environment and, thereby, deliver superior aviation weather products to end users.

Weather Support to Deicing Decision Making. This system develops products that provide forecasts on the intensity of snow and freezing rain, and how or when these phenomena will change in the short term. This information is needed by airport management to determine when an aircraft will require deicing before take-off. The water content of snow is believed to be an important factor. FAA has made this system available to airport authorities that wish to use it as a decision aid.

Other Aviation Weather Research. Other aviation weather research programs that are continuing, but at a lower level of funding, pertain to ceiling and visibility, and turbulence detection.

The FHWA vision is to create:

- *the safest and most efficient and effective highway and intermodal transportation system in the world;*
- *a transportation system where crashes, delays, and congestion are significantly reduced;*
- *a transportation system where freight moves easily and at the lowest costs;*
- *a system where roads protect ecosystems and where travel on our roadways does not degrade environmental quality;*
- *a system where transit, pedestrians, and bicyclists are accommodated; and*
- *a system where transportation services are restored immediately after disasters and emergencies*.

The Federal Highway Administration (FHWA) manages the Federal-Aid Highway Program that provides federal financial and technical assistance to the states to plan, construct, and improve the National Highway System, urban and rural roads, and bridges. The Motor Carrier Safety Program of the FHWA promotes safe commercial motor vehicle operations to reduce crashes. The Federal Lands Highway Program provides access to and within National Forests, National Parks, Indian Lands and other public lands by administering the Federal Lands Highway, Emergency Relief, and Defense Access Roads Programs. Safety, efficiency and mobility in all these programs requires improved Road Weather Information Systems (RWIS) that include specialized road condition sensors and forecast services from the National Weather Service (NWS) and private vendors. The FHWA is expanding the RWIS scope to a Weather Information for Surface Transportation (WIST) system as part of intermodal surface transportation technology development and within the context of Intelligent Transportation Systems (ITS).

Although the FHWA does not build nor operate highways, other than through the Federal Lands Highway Program, it accomplishes its mission by providing leadership, expertise, resources and information in cooperation with state and local highway agencies who do own and operate the roads. The FHWA has a significant role, working through partnerships, programs, policies, and allocating resources which facilitate the strategic development, maintenance, and operation of state and local transportation systems.

The FHWA's strategic goals to support its mission and achieve its vision are: *mobility*, including the objective to reduce delays on Federal-aid highways by 20 percent in 10 years; *safety*, including the objective to achieve 20 percent reduction in the number of highway-related fatalities and serious injuries in 10 years; *productivity* through more efficient transportation; *human and natural environment* by reducing highway-related pollution, and; *national security* through improving the Nation's national defense mobility.

Weather information to support decisions by highway managers, fleet managers, and travelers is a vital part of achieving FHWA's strategic goals. Mobility, productivity, and national security are dependent on weather information for timely and appropriate highway snow and ice treatment, route closures, and trip planning to avoid adverse conditions and areas. The natural environment is affected by runoff of ice treatment materials and by air pollutants from vehicles. The impacts of both runoff and pollutants can be better managed with improved weather information. Above all, weather is a factor in safety. Each year, more than 40,000 Americans die and 3 million more are injured in motor vehicle crashes on our highways. Adverse weather conditions are associated with 18 percent of fatal crashes and 21 percent of injury crashes. In addition to these injuries and fatalities, incident management to save lives depends on weather information for improved dispatching of response resources.

The FHWA has been active in promoting RWIS development. These remote-sensing systems have primarily served the snow removal and ice treatment functions of highway management. Some states cooperate with the NWS in operating joint weather observation sites or sharing data from the roadside sensor systems. Both Colorado and Minnesota State DOT's share the weather data from the roadside mesonets with the NWS forecast offices.

The FHWA is now pursuing an expanded scope of its WIST system development as an effort that cuts across several programs. In January, 1997, the FHWA formed a Weather Team to develop weather information requirements using the ITS program and the National ITS Architecture as a framework. The Weather Team directly coordinates activities of offices within the FHWA that are concerned with weather information for surface transportation. Most of this work takes place within the Operations Core Business Unit, but is also coordinated across the other business units of Infrastructure, Planning and Environment, Federal Lands Highways, and Motor Carrier and Highway Safety. The Service Business Unit of Research, Development, and Technology also participates in the program. Through the ITS Joint Program Office, which is housed within the Operations Core Business Unit, and via the OFCM, the Weather Team is fostering cooperative agreements between the surface transportation administrations of DOT and other federal agencies with meteorological programs and services.

Regular federal aid for projects can include ITS and weather information components. The Surface Transportation Research Program under the Transportation Equity Act for the 21st Century (TEA-21) includes provisions to sponsor weather-related projects. A large part of surface transportation research is conducted through university research grants and federal-aid research funds that are apportioned to the 50 states. States can also pool their research funds to focus on specific program areas. For example, the Aurora consortium was formed in this manner specifically to address surface transportation weather information issues. In the early 1990's, the Strategic Highway Research Program (SHRP) included an RWIS study (SHRP-H-350 and 351--1993) to investigate the role of improved weather sensing to achieve more effective highway snow and ice treatment. SHRP was a unit of the National Research Council and studies a number of transportation-related subjects including RWIS.

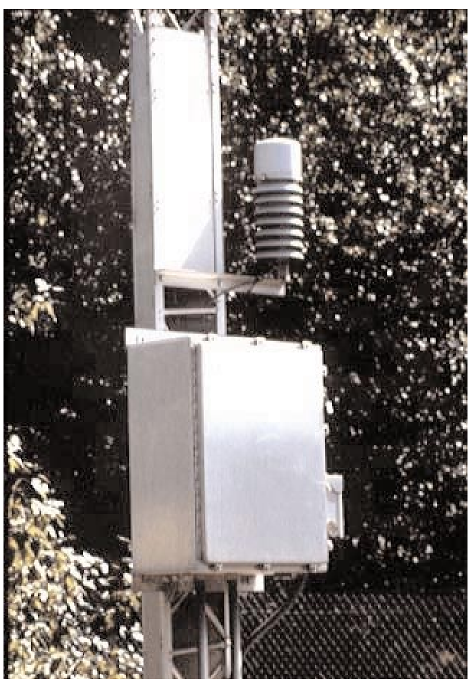

Figure 3-DOT-3. State DOTs with funding from FHWA are deploying Road Weather Information System along major highways throughout the country.

Based on the SHRP findings and further field testing and evaluation, the FHWA has published the *Manual for an Effective Anti-Icing Program* (FHWA-RD-95-202--1996). The manual provided guidance to maintenance managers and focused on implementation of a systematic and efficient anti-icing program.

In 1997, the FHWA began funding a 30-month operational test on a weather information system proposed by the Foretell consortium. The Foretell consortium is a private-public partnership and includes the DOTs of several states, federal agencies, and private industry. The Foretell project will forge new dissemination links between user of weather information and the Local Analysis and Prediction System (LAPS) being developed by NOAA's Forecast Systems Laboratory (FSL) for the NWS's Weather Forecast Offices (WFOs).

Within the WIST system, the team envisions a need for better highway-specific observations that include more surface weather parameters and higher resolution forecasts provided by mesoscale numerical models at 1-3 hourly intervals. However, this increased volume of weather information will result in a demanding data assimilation and processing task for highway maintenance and other decision makers. A white paper prepared by the FHWA Weather Team identifies decision support and graphical aids as the key focus of surface transportation interests. Consequently, the team's agenda includes development of ITS components that filter, fuse, and present weather and other transportation information into visual aids that can facilitate specific decisions for road maintenance personnel, local transportation officials, commuters, travelers, trucking industry, etc. Of particular interest are risk-based decision making techniques and processes that include the incorporation of statistical information. These risk-based decisions encompass a myriad of variables and scales, i.e., observations from standard and non-standard sources, synoptic to mesoscale models, current and climatic data, etc. which must be fused with other meteorological guidance and transportation user requirements to produce mid- and long-range planning information.

In FY 2000, the FHWA will coordinate its meteorological activities through the Weather and Winter Mobility Program within the Office of Transportation Operations, Operations Core Business Unit. The Weather Team will be rechartered as a cross-agency coordination group. The Weather Team's first operational test, FORETELL, will be operational in the winter of 1999-2000. An evaluation will begin to assess user acceptance among highway maintenance decision-makers. Research projects and another operational test will be initiated, focusing on decision support and RWIS observation assimilation.

As part of the OFCM effort to document surface transportation weather requirements, FHWA will conduct a requirements study that will focus initially on winter road maintenance. This study will develop detailed weather event and operational decision scenarios which will serve to define operational concepts. The operational concepts will lead to the development of requirements and, within the ITS context, the conceptual WIST system. Stakeholder groups representing both public and private interests will be solicited to participate in the study. In addition, several of the national R&D laboratories will be enlisted to define state-of-the-art concepts for system definition.

Although no Coast Guard cutters or shore units are solely dedicated to meteorology, they collectively perform a variety of functions in support of the national meteorology program. USCG ocean-going cutters and coastal stations provide weather observations to the NWS. Coast Guard communications stations broadcast NWS marine forecasts, weather warnings, and weather facsimile charts and, also, collect weather observations from commercial shipping for the NWS. The Coast Guard also operates the LORAN C radionavigation system and the Maritime Differential GPS (DGPS) Service, which provide positioning data for meteorological observation (e.g. radiosondes). The LORAN C system provides Position, Navigation, and Timing (PNT) information to a variety of navigation and non-navigation users throughout the continental United States and Alaska. The Maritime DGPS Service is an augmentation to the GPS that improves GPS only accuracy to better than ten meters and provides DGPS coverage to coastal areas of the continental United States, the Great Lakes, Puerto Rico, portions of Alaska and Hawaii, and portions of the Mississippi River Basin.

USCG maintains the International Ice Patrol (IIP) which uses sensor-equipped aircraft to patrol the Grand Banks of Newfoundland to locate and track icebergs which pose a hazard to North Atlantic shipping. Direct observations are supplemented and extrapolated using a numerical iceberg drift and deterioration model. IIP determines the geographic limits of the iceberg hazard and, twice daily, broadcasts iceberg warning bulletins and ice facsimile charts which define the limits of the iceberg threat during the iceberg season (spring and summer). IIP annually archives data on all confirmed and suspected targets, and forward these data to the National Snow and Ice Data Center. These data can be accessed via the IIP web page *www.uscg.mil/lantarea/iip/home.html*. Archived data contains all iceberg sighting data along with the last model-predicted position of each berg.

Figure 3-DOT-4. USCG Seagoing Buoy Tenders (WLD) provide maintenance platforms for NOAA's National Data Buoy Center.

The Coast Guard participates with the Navy and NOAA in conducting the National Ice Center, a multi-agency operational center that produces analyses and forecasts of Arctic, Antarctic, Great Lakes, and coastal ice conditions.

The Coast Guard also collaborates with NOAA in operating the National Data Buoy Center (NDBC) which deploys and maintains NOAA's automated network of environmental monitoring platforms in the deep ocean and coastal regions. Twelve Coast Guard personnel fill key technical and logistics support positions within NDBC, with the senior Coast Guard officer assigned serving as the NDBC Deputy Director Coast Guard cutters support the deployment and retrieval of data buoys, and provide periodic maintenance visits to both buoys and coastal stations, expending approximately 180 cutter days annually. Coast Guard aircraft, small boats, and shore facilities also provide NDBC support.

Meteorological activities are coordinated by the Icebreaking Division of the Office of Aids to Navigation Safety and Waterways Services at Coast Guard Headquarters. Field management of Coast Guard meteorological support services is accomplished as the Coast Guard Area and District levels.